

Code of Practice for Industrial Radiography

ORS C7

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Introduction

Purpose and commencement

This Code of Practice for Industrial Radiography ('the code') is issued by the Director for Radiation Safety ('the Director') under section 86 of the Radiation Safety Act 2016 ('the Act'). It provides operational details necessary to comply with the fundamental requirements in sections 9 to 12 of the Act. Appendix 1 sets out cross-references between clauses in this code and those fundamental requirements. The requirements in this code do not limit the general nature of the fundamental requirements. This code comes into force on 07/06/19.

Scope

This code applies to activities associated with radiation sources used for the non-destructive testing of items of equipment and structures such as vessels, pipes, welded joints, castings and other devices to verify their physical integrity. This relates to X-ray equipment and gamma sources in fixed shielded facilities and outside shielded facilities using mobile sources.

Activities can include manufacturing, possessing, controlling, managing, using, storing, importing, exporting, selling, supplying and disposing of radiation sources.

The following issues are dealt with in separate codes of practice:

- safety of radioactive material in transport
- security of radioactive material in use, storage or transport.

Compliance with this code does not imply compliance in related areas such as occupational safety, hazards in the workplace, resource management and transport of hazardous substances.

Contact

The Director's contact details are:

Office of Radiation Safety
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Wellington 6140

Email: orsenquiries@health.govt.nz
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Roles and responsibilities

The following individuals and bodies have roles and responsibilities in relation to this code.

Client – the organisation or person responsible for hiring the managing entity to perform industrial radiography work.

Director for Radiation Safety – the individual appointed under section 76 of the Act to perform functions and duties and exercise powers set out in the Act, including the power to issue this code.

Managing entity – the legal entity that manages or controls radiation sources and must, therefore, obtain a source licence as required by section 13(a) of the Act. Normally this is an incorporated company.

Manufacturer/supplier – the person or organisation that designs, manufactures, produces, constructs, assembles, installs, distributes, sells, exports or imports radiation sources or develops software that could influence the delivery of exposures.

Qualified expert – an individual who is recognised as having expertise in a relevant field of specialisation such as the design of radiography facilities, radiation shielding calculations, and testing and maintenance of radiation survey meters.

Radiation safety officer – a person who is competent in radiation protection and safety who is designated by the managing entity to oversee the application of regulatory requirements for radiation protection and safety. This should be a person with seniority in the organisation who has the authority to ensure that regulatory requirements are met.

Radiographer – a person who is competent to independently oversee the use of radiation sources in industrial radiography procedures.

Servicing engineer – a person who has expertise in installing, servicing and maintaining X-ray equipment and exposure devices.

Standards dosimetry laboratory – a laboratory that is certified or accredited to develop, maintain or improve primary or secondary standards for radiation dosimetry.

Technical assistant – a person who is competent to assist a radiographer in an industrial radiography procedure.

Definitions

Defined terms are identified in **bold** and have the following meanings.

Accident – any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of **protection and safety**.

Ancillary equipment – equipment other than **radiography equipment** that is important to the safe performance of **radiography procedures**, such as radiation survey meters, radiation monitoring devices, collimators, local shielding, guide tubes, control cables, remote controls, image receptors, boundary markers, emergency kits, notices and devices to warn of impending or current exposures.

Constraint – a prospective and source related value of individual dose (dose constraint) or of individual risk (risk constraint) that is used in **planned exposure situations** as a parameter for the **optimisation** of **protection and safety** for the source, and that serves as a boundary in defining the range of options in **optimisation**. Constraints for **occupational exposure** and **public exposure** are established or approved by the Director and, if established, are published in a compliance guide issued under this code.

Controlled area – a defined area in which specific measures for **protection and safety** are or could be required for controlling exposures in normal working conditions, and preventing or limiting the likelihood and magnitude of **potential exposures**.

Dose limit – the value of **effective dose** or **equivalent dose** set out in Schedule 3 of the Act.

Effective dose – the tissue-weighted sum of **equivalent doses** in all specified tissues and organs of the body.

Emergency – any non-routine situation that necessitates prompt action, primarily to mitigate actual or perceived hazards or adverse consequences for human health and safety, quality of life, property or the environment. This includes **radiation emergencies** and conventional emergencies such as fires, release of hazardous chemicals, storms or earthquakes.

Emergency equipment – equipment other than **radiography equipment** and **ancillary equipment** for use in an **emergency** such as bags of lead shot, extra lead sheet, suitable tool kits, source recovery equipment, spare shielded container, communication equipment, spare batteries, pens, paper, calculator, incident log book and equipment manuals.

Employer – the legal entity that employs **workers**. A self-employed person is regarded as being both an employer and a worker.

Equivalent dose – the radiation-weighted dose in a tissue or organ of the body.

Exposure bay – a shielded enclosed area within a **facility** used for **in-house radiography**.

Exposure device – a shielded device that includes a remote wind-out mechanism and guide tube, which can house a radioactive source for **gamma radiography**.

Facility – the location where **radiography equipment** is installed, used, handled or stored.

Gamma radiography – radiography using a **gamma source**.

Gamma source – a radioactive source that emits gamma rays for the purpose of industrial radiography together with any **exposure device** in which it is enclosed.

Incident – any **accident** or other unintended event, including initiating events, accident precursors, near misses or other mishaps; or unauthorised acts, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of **protection and safety**.

Individual monitoring – **monitoring** using equipment worn by individuals.

In-house radiography – radiography performed in an **exposure bay**.

Investigation level – the value of a quantity such as effective dose, intake or contamination per unit area or volume at or above which an investigation would be conducted.

Justify – to determine that the expected benefits to individuals and society from introducing or continuing a practice outweigh the harm, including the radiation detriment, resulting from the practice. 'Justifies', 'justified' and 'justification' have corresponding meanings.

Medical exposure – exposure to ionising radiation experienced by patients for the purposes of medical or dental diagnosis or treatment, by comforter/carers while caring for, supporting, or comforting patients, and by volunteers in a programme of medical research.

Member of the public – for purposes of **protection and safety**, any individual in the population except when subject to **occupational exposure** or **medical exposure**.

Monitoring – the measurement of dose or dose rate to enable the assessment or control of exposure due to radiation, and the interpretation of the results.

Occupational exposure – exposure of **workers** incurred in the course of their work.

Occupationally exposed person – any person who is subject to **occupational exposure**.

Operational limits and conditions – limits and conditions that are established or approved by the Director and, if established, are published in compliance guides issued under this code.

Optimise – to implement a level of **protection and safety** that results in the magnitude of individual doses, the number of individuals (**workers** and **members of the public**) subject to exposure and the likelihood of exposure being as low as reasonably achievable, with economic and social factors being taken into account. 'Optimises', 'optimised' and 'optimisation' have corresponding meanings.

Planned exposure situation – a situation of exposure that arises from the planned operation of **radiography equipment** or from a planned activity that results in an exposure due to **radiography equipment**.

Potential exposure – possible future exposure that may result from an anticipated operational occurrence or **accident** at a source or due to an event or sequence of events of a probabilistic nature, including equipment faults and operating errors.

Protection and safety – the protection of people against exposure to ionising radiation and the safety of **radiography equipment**, including the means for achieving this, and the means for preventing **accidents** and for mitigating the consequences of **accidents** if they do occur.

Public exposure – exposure to ionising radiation that a **member of the public** experiences, but excluding any **occupational exposure** or **medical exposure**.

Radiation emergency – an **emergency** in which there is, or is perceived to be, a hazard due to radiation exposure.

Radiography equipment – **gamma source** or **X-ray equipment** and any associated software used to perform **radiography procedures**.

Radiography procedure – a procedure delivered by **radiography equipment** for the non-destructive testing of items of equipment and structures.

Reportable incident – an **incident** resulting in a **dose limit** being exceeded or **radiography equipment** that is lost, missing or beyond regulatory control.

Safety assessment – assessment of all aspects of a practice that are relevant to **protection and safety** to determine the adequacy of provisions for **protection and safety**.

Site radiography – radiography performed outside an **exposure bay**.

Storage room – enclosed room within a **facility** used to store **radiography equipment**.

Worker – an individual who works, whether full time, part time or temporarily, for the managing entity or another **employer** and who has recognised rights and duties in relation to occupational radiation protection. A self-employed person is regarded as being both an employer and a worker.

Workplace monitoring – **monitoring** carried out in the working environment.

X-ray equipment – equipment that emits X-rays for the purpose of industrial radiography.

X-ray radiography – radiography using **X-ray equipment**.

Managing entity

General

1. The managing entity must:
 - a) take prime responsibility for protection and safety
 - b) establish a management system to enhance protection and safety that includes:
 - i) effectively integrating protection and safety into the overall management system of the organisation
 - ii) making a commitment to protection and safety from the highest level of management at the facility, and by providing all required resources
 - iii) promoting continuous improvement and a safety culture
 - iv) appointing an in-house employee as a radiation safety officer to oversee the application of regulatory requirements
 - v) delegating the planning and delivery of radiography procedures to a radiographer
 - vi) consulting with and engaging the services of qualified experts and other interested parties as necessary to ensure that the requirements of this code are met
 - c) for all delegations under sub-clauses 1(b)(iv) and 1(b)(v):
 - i) ensure delegates are notified of their duties in relation to protection and safety and assume responsibility for performing them
 - ii) fully document the delegations
 - d) ensure that:
 - i) all activities associated with radiography equipment are justified and optimised for protection and safety
 - ii) dose limits for occupational and public exposure are not exceeded as a result of those activities
 - iii) the requirements for site radiography are met whenever the requirements for in-house radiography in an enclosure bay are not met.

Safety assessment

2. The managing entity must conduct, document and keep up to date a comprehensive safety assessment to:
 - a) identify the ways in which occupational and public exposures could be incurred, including consideration of:
 - i) dose rates from both shielded and unshielded radiation sources
 - ii) limits and technical conditions for operation of sources
 - iii) ways in which external factors could affect protection and safety
 - iv) ways in which operating errors and human factors could affect protection and safety
 - v) evaluation and implications of any proposed modifications for protection and safety
 - b) determine:
 - i) the expected likelihood and magnitudes of exposures in normal operation and, to the extent reasonable and practicable, assess potential exposures of radiographers, other workers and the public, for a range of scenarios representing normal use and reasonably foreseeable incidents
 - ii) ways in which structures, systems and components, as well as procedures relating to protection and safety, might fail or might otherwise lead to potential exposures, and the consequences of such failures
 - c) assess the adequacy of provisions for protection and safety in respect of siting, design and operation.

Facilities

3. The managing entity must:
 - a) provide facilities that:
 - i) are located, designed, manufactured, constructed, assembled, commissioned, operated, maintained and decommissioned adopting good engineering practice, minimising the need to rely on administrative controls and personal protective equipment for protection and safety
 - ii) satisfy the facility requirements in Appendix 2
 - b) designate and delineate exposure bays and storage rooms as controlled areas
 - c) periodically review the designations and delineations in clause 3(b)

- d) shield all exposure bays and storage rooms so that:
 - i) no person can receive a dose exceeding 0.3 mSv per year from occupying areas outside the area
 - ii) the dose rate at any accessible point outside the area is less than 15 μ Sv per hour
- e) verify and document the adequacy of the shielding in controlled areas whenever circumstances change that could increase the risks
- f) prominently display signs:
 - i) specifying the actual or potential presence of ionising radiation using the symbol recommended by the International Organization for Standardization at access points to controlled areas and supervised areas and at appropriate locations within controlled areas
 - ii) controlling unauthorised access to controlled areas and supervised areas
- g) formally decommission any facility if there are no plans to use it again in the foreseeable future, including:
 - i) dealing with all radiography equipment in accordance with clause 5
 - ii) removing all radiation trefoils and notices from the facility
 - iii) conducting a comprehensive radiation survey to confirm that no radiography equipment has been left on the site and that there is no contamination
 - iv) preparing a final decommissioning report that includes the final radiation survey and details of the storage, transfer or disposal of radiography equipment
 - v) submitting the final decommissioning report to the Office of Radiation Safety.

Equipment

- 4. The managing entity must:
 - a) ensure that radiography equipment, radiation survey meters, personal alarm monitors and ancillary equipment are provided, routinely inspected, maintained, tested, calibrated, serviced and safely managed so that:
 - i) the equipment is appropriate for the radiography procedures to be performed and enables those procedures to be carried out safely and effectively
 - ii) the equipment remains capable of fulfilling its design requirements for protection and safety throughout its lifetime
 - iii) equipment is not modified without a prior assessment reviewed by a qualified expert of the supplier of the implications of the modification for the original design and the safety assessment

- b) ensure that the requirements in Appendix 3 are satisfied
 - c) cooperate with manufacturer/suppliers to:
 - i) ensure that the requirements in sub-clauses 4(a) and 4(b) are met
 - ii) ensure that radiography equipment is used only if it conforms to the applicable standards of the International Electrotechnical Commission and the International Organization for Standardization
 - iii) share information on use and operating experience that may be important for protection and safety
 - iv) apply the principles of optimisation in the design, planning and operation and decommissioning of a source
 - d) maintain an accurate inventory of all radiography equipment, including its location and description
 - e) maintain a record of maintenance for each item of radiography equipment, including:
 - i) a fault log and remedial actions taken (interim and subsequent repairs)
 - ii) the results of testing before an item is reintroduced to use
 - iii) any reports from servicing engineers.
5. On cessation of operations the managing entity must, in addition to the requirements in clause 3(g) ensure that:
- a) all gamma sources and exposure devices containing depleted uranium are:
 - i) returned to the manufacturer
 - ii) transferred to another person or organisation that is authorised under the Radiation Safety Act 2016 to accept them, or
 - iii) disposed of in accordance with requirements issued by the Office of Radiation Safety
 - b) all X-ray equipment is:
 - i) made inoperable, or
 - ii) transferred to another person or organisation that is authorised to manage or control the equipment under the Radiation Safety Act 2016.

Training and authorisation

6. The managing entity must ensure that:
 - a) all persons with responsibilities for protection and safety:
 - i) are qualified, educated and trained in protection and safety so that they understand their duties and can perform them competently
 - ii) satisfy the training requirements in Appendix 4
 - b) all radiographers hold a use licence under the Radiation Safety Act 2016
 - c) technical assistants use radiography equipment only under the direct supervision of a radiographer.

Site radiography

7. Prior to the commencement of site radiography, the managing entity must:
 - a) notify the Office of Radiation Safety at least 5 days in advance of any work that is expected to last for two weeks or more with details of:
 - i) the responsible radiation safety officer
 - ii) proposed dates of the radiography
 - iii) physical address of the site where radiography will be carried out
 - iv) radiation sources to be used
 - b) identify any site-specific issues that need to be addressed
 - c) ensure that radiographers are aware of those site-specific issues
 - d) consult with the client on the preparation and planning of the radiography procedures, including:
 - i) agreeing the planned timescale of the work and the duration of the period over which radiography work will be performed
 - ii) informing the client about the type of radiography equipment to be used
 - iii) ensuring if necessary that any radiography equipment can be stored safely
 - iv) providing the client with a copy of the managing entity's local rules and emergency plans
 - e) ensure that at least one radiographer and one other person are available for each item of radiography equipment to be used at any one time.

Policies, procedures and local rules

8. The managing entity must establish, implement and maintain policies, procedures and local rules to meet the requirements of this code, including, without limitation, policies, procedures and local rules to:
 - a) control access to areas where people can be exposed to radiation
 - b) describe locations to be subject to workplace monitoring, the frequency of monitoring and the records to be kept
 - c) carry out site radiography only when it is not practicable to perform the work in an enclosure bay
 - d) use constraints to optimise protection and safety
 - e) prevent accidents and emergencies and mitigate the consequences of any that occur
 - f) report on and learn from accidents and other incidents
 - g) comply with operational limits and conditions relating to public exposure
 - h) provide protection and safety by applying preventive measures in the following hierarchy:
 - i) engineered controls
 - ii) administrative controls
 - iii) personal protective equipment
 - i) set investigation levels and establish procedures to follow if such a level is exceeded
 - j) ensure that information on the safe use of equipment is provided to users
 - k) implement procedures for verification of compliance with this code
 - l) periodically review the overall effectiveness of measures for protection and safety.

Monitoring and measurement

9. The managing entity must establish and maintain:
 - a) a programme of continuous individual monitoring whenever appropriate, adequate and feasible, which is sufficient to assess occupational exposures for workers who usually work in a controlled area or who may receive a dose exceeding 10 percent of the dose limits
 - b) a programme of workplace monitoring for radiography in shielded enclosures:
 - i) around walls and doors and other openings of the enclosure under a range of operating conditions, to ensure that an adequate level of shielding is maintained

- ii) at the entrance to the enclosure bay and around the exposure device after completion of each gamma radiography exposure, to confirm that the gamma source has been satisfactorily returned to the exposure device or that X-ray emission has stopped
 - iii) around the gamma source store, to ensure that an adequate level of shielding is provided
- c) a programme of workplace monitoring for site radiography work:
 - i) around barriers during test exposure (or first exposure depending on the circumstances) to confirm that the barriers are correctly positioned
 - ii) at the operator position during wind-out of a gamma source or when an X-ray generator is energised to confirm that radiation levels are not unacceptable
 - iii) around barriers during routine exposures to confirm that dose rates remain below values specified in this code
 - iv) at the operator position during wind-in of a gamma source or termination of exposure of an X-ray generator
 - v) around the exposure device after each exposure to ensure that the source has been fully returned to the shielded position
 - vi) around any source store used on-site to ensure that an adequate level of shielding is provided
 - vii) around the site on completion of the radiography work to confirm that no gamma sources have been left on the site
 - viii) around vehicles used to transport gamma sources prior to departure to and from the site
- d) a monitoring programme for all workers who could be subject to exposure due to contamination, which is sufficient to:
 - i) demonstrate the effectiveness of the measures for protection and safety
 - ii) assess intakes of radionuclides and committed effective doses
- e) programmes of source monitoring or environmental monitoring that are sufficient to assess public exposure arising from radiography equipment under the responsibility of the managing entity
- f) a capability that is sufficient to monitor unexpected increases in radiation levels due to an incident attributed to a source or facility for which the managing entity is responsible
- g) other monitoring or measurement programmes as necessary to verify compliance with the requirements in this code.

10. In order to satisfy the monitoring and measurement requirements in clause 9 the managing entity must:
 - a) use appropriate monitoring equipment
 - b) for continuous individual monitoring under clause 9(a), use an external service or internal capability only if that service or capability:
 - i) is approved by the Director
 - ii) returns results to the managing entity within 20 working days of receiving all necessary raw information.

11. The managing entity must:
 - a) use best endeavours to obtain previous dose records for all workers
 - b) maintain records of all monitoring and verification of compliance, including:
 - i) records of occupational exposure during and after the worker's working life, at least until the worker attains or would have attained the age of 75 years, and for not less than 30 years after ceasing work where the worker was subject to occupational exposure
 - ii) records and estimated doses to members of the public
 - iii) records of the tests and calibrations carried out
 - c) provide records of occupational exposure to:
 - i) individual workers in respect of their own exposure
 - ii) subsequent employers of workers, subject to satisfying confidentiality criteria
 - iii) the Director on request or if the managing entity is no longer able to maintain records as required under clause 11(b)
 - d) provide records of source monitoring and environmental monitoring to assess public exposure to:
 - i) members of the public on request
 - ii) the Director on request
 - iii) the Director immediately, if any levels exceed operational limits and conditions relating to public exposure or there is a significant increase in dose rate that could be attributed to the authorised practice.

Incidents, accidents and emergencies

12. The managing entity must:
 - a) take all practicable steps to minimise the likelihood of accidents, including a multilevel system of sequential, independent provisions for protection and safety, commensurate with the likelihood and magnitude of potential exposures
 - b) take timely action to mitigate the consequences of any accident that does occur and restore radiography equipment to a safe condition
 - c) promptly investigate any incident, including by:
 - i) calculating or estimating doses a person has received and, if applicable, the dose distribution within them
 - ii) identifying corrective actions required to prevent a recurrence
 - d) implement all corrective actions identified in clause 12(c)(ii)
 - e) keep a written record of the incident, including the:
 - i) cause or suspected cause
 - ii) calculations made under clause 12(c)(i)
 - iii) corrective actions identified under clause 12(c)(ii)
 - iv) details of the implementation of corrective actions under clause 12(d)
 - f) promptly notify any reportable incident to the Director.
13. If the safety assessment required by clause 2 indicates that there is a reasonable likelihood of an emergency affecting either workers or members of the public, the managing entity must prepare and maintain an emergency plan for the protection of people and the environment, including:
 - a) arrangements for promptly identifying an emergency
 - b) determining the correct level of emergency response
 - c) provision for individual monitoring, area monitoring and arrangements for medical treatment
 - d) arrangements for assessing and mitigating any consequences of an emergency.
14. The managing entity must:
 - a) conduct emergency exercises at appropriate intervals
 - b) ensure that external parties know their expectations if they are part of the emergency plan.

Records

15. The managing entity must maintain adequate records, and make them available as necessary, including:
 - a) the management structure as it relates to radiation safety
 - b) the delegation of responsibilities of the managing entity and the radiation practitioner
 - c) the names of all people with responsibility for protection and safety, including details of their qualifications, education and training
 - d) the design and shielding of exposure bays and storage rooms
 - e) the quality assurance programme
 - f) information necessary for the retrospective assessment of doses
 - g) reports on investigations of unintended and accidental medical exposures
 - h) exemptions from this code granted under section 86(3) of the Act.

Quality assurance

16. The managing entity must establish a comprehensive quality assurance programme, including:
 - a) maintenance of all equipment used for gamma radiography by specially trained operators at least annually, including detailed inspection of all the components
 - b) a complete and detailed inspection and testing of X-ray equipment and its components at least annually, including:
 - i) checks for electrical safety, including earth grounding and tests of electrical insulation of cables
 - ii) cleaning or replacement of any filters in cooling systems
 - iii) checks to ensure that all cables are in good condition with no fraying or bare wires
 - iv) other routine checks and maintenance as recommended by the manufacturer
 - v) tests on all interlocks and emergency cut-out switches
 - vi) tests on any permanently installed radiation detectors inside the shielded enclosures (ensuring that this is done while no-one is inside the enclosure)
 - c) testing and maintenance of exposure bays and storage rooms to ensure the requirements in this code are satisfied, including requirements for appropriate safety systems and warning systems
 - d) maintaining records of relevant procedures and results.

Radiographer

General

17. The radiographer:
- a) is responsible for overall protection and safety in the planning and delivery of radiography procedures
 - b) must work safely and take all reasonable actions to minimise exposure to themselves and to other workers and members of the public by:
 - i) following local rules and any relevant procedures established by the managing entity
 - ii) wearing their individual dosimeters in the correct place at all times during radiography work and source manipulation
 - iii) using radiation monitors and radiation survey meters properly and in a systematic manner
 - iv) performing routine operational checks of radiation monitors and radiation survey meters in collaboration with the radiation safety officer to ensure that they are working properly
 - v) cooperating with the radiation safety officer and qualified experts on all radiation safety issues
 - vi) participating in any training concerning radiation safety
 - vii) abstaining from any wilful action that could put themselves or others in contravention of regulation requirements or of the managing entity's requirements
 - viii) using collimators and additional shielding as appropriate to minimise potential exposure
 - ix) verifying before each exposure that no one is inside the exposure bay and close the door before initiating the exposure
 - x) locking off source containers and x-ray control panels between exposures and removing the keys
 - c) must:
 - i) promptly inform the radiation safety officer of any incident or circumstances that could result in higher than usual radiation doses to themselves or to other persons
 - ii) provide a written report to the radiation safety officer as soon as practicable after the incident or circumstance
 - d) may delegate functions to a technical assistant but only if the industrial radiographer is physically present and able to intervene.¹

¹ The managing entity has obligations under clause 1 to ensure that these delegations are notified and documented and that delegates assume responsibility for the delegated functions.

Routine inspections

18. Before commencing gamma radiography the radiographer must carry out routine inspections of equipment to detect conditions that could lead to an incident if left uncorrected, including inspecting:
 - a) the exposure device, to ensure that:
 - i) fittings and fasteners are tight
 - ii) the locking mechanism functions properly
 - iii) radiation levels are normal
 - iv) connections of the guide tube and the control mechanism are secure
 - v) the source assembly connection and the drive cable is verified to be secure using a wear gauge
 - b) the remote controls, to ensure that:
 - i) fittings are tight
 - ii) there are no indications of crushing, kinks or dents
 - iii) the drive cable can move freely
 - c) the source guide tubes, to ensure that:
 - i) fittings are tight
 - ii) there are no indications of crushing, kinks or dents
 - iii) source tips are not worn through
 - d) additional ancillary equipment such as magnetic stands, vice grip clamps and collimator attachments, to ensure:
 - i) freedom of movement
 - ii) good working condition
 - iii) appropriateness for use.
19. When performing a source exchange, the radiographer must perform pre-operational checks to ensure that:
 - a) lock assemblies function properly
 - b) guide tube and transfer tube connections are secure
 - c) there are no obstructions in the guide tubes or transfer tubes.
20. Before commencing radiography using X-ray equipment, the radiographer must carry out routine inspections of equipment to detect conditions that could lead to an incident if left uncorrected, including:
 - a) no visible damage to the equipment
 - b) cables have no cuts, breaks, kinks or broken fittings
 - c) any liquid cooling systems are not leaking
 - d) all interlocks are operational

- e) all warning indicators and lights are functioning properly
 - f) fasteners are tight and threaded connections are secure.
21. If any faults are found during these inspections the equipment must not be used until it has been repaired or replaced.
22. The radiographer must:
- a) check the functionality of the survey meter
 - b) measure dose rates outside the exposure bay at a range of positions, including the operator's position and adjacent occupied areas, and terminate exposures if they exceed reference levels set out in this code.

Site radiography

23. The radiographer must:
- a) designate an area as a controlled area so that the dose rate at the boundary of the area does not exceed 25 μSv per hour with the source exposed (apart from when it is being wound out or in through the guide tube)
 - b) ensure that no person can receive a dose exceeding 0.3 mSv per year outside the controlled area resulting from the radiography
 - c) ensure that no other work is permitted in this area until the radiography work has been finished and the controlled area is no longer so-designated
 - d) demarcate the controlled area by physical means
 - e) prevent unauthorised access to the controlled area
 - f) place the gamma wind-out mechanism or X-ray equipment control panel in such a position as to minimise doses to themselves when initiating and ending an exposure
 - g) issue a clearly visible and/or audible signal whenever radiation exposures are taking place
 - h) display notices at suitable positions on the boundary of the controlled area:
 - i) bearing the radiation symbol, warnings and appropriate instructions
 - ii) explaining the meaning of the signals set out in clause 23(g)
 - i) clear the controlled area of all persons except radiographers and technical assistants who will be involved in the procedure
 - j) ensure that the boundary of the controlled area is clearly visible, well lit and constantly patrolled during radiography exposures to ensure that no unauthorised persons enter the area
 - k) measure dose rates around the barriers during a test exposure to confirm that the barriers are correctly positioned
 - l) adjust the boundary to the controlled area if necessary to comply with the dose rate requirements in clause 23(a)

- m) check the functionality of the survey meter and personal alarm monitors prior to use
- n) use the radiation survey meter at all times when approaching a radiation source
- o) wear personal dosimeters and personal alarm monitors during the entire period for which they may be exposed to radiation
- p) use a radiation survey meter on completion of work to ensure that all gamma sources have been fully retracted into the exposure device and that no sources have been left in the exposed position or have become detached
- q) carry out a visual inspection before leaving a site (site radiography) to ensure that equipment has not been damaged
- r) before using X-ray equipment:
 - i) check for visible damage
 - ii) check the X-ray tube and all bare ends of the cable for damage, wear, dirt or moisture
 - iii) check screws and nuts for tightness and screw threads for damage
 - iv) inspect cables for cuts, breaks, kinks and broken fittings
 - v) check exposure factor settings for legibility
- s) if problems are found as a result of the checks and inspections in clause 23(r), refrain from using the equipment until it is replaced or repaired.

Other parties

Radiation safety officer

24. The radiation safety officer must oversee the day-to-day implementation of regulatory requirements by the managing entity, including:
 - a) maintenance of source inventory records
 - b) inspection and maintenance of engineering controls, safety features and warning features
 - c) oversight of access control for controlled areas
 - d) establishment and periodic review of arrangements for personal dosimetry, including maintenance and review of occupational dose records
 - e) performance of routine operational checks of radiation survey meters and personal alarm monitors in collaboration with the radiographers to ensure that the instruments are working properly
 - f) ensuring that radiographers are suitably trained in the use of equipment and radiation protection, and that they receive regular refresher training
 - g) ensuring that emergency plans are established and that they are practised regularly
 - h) supervision of workplace monitoring arrangements
 - i) establishment, issue and periodic review of local rules
 - j) investigation of higher than usual exposures and overexposures
 - k) investigation and reporting of incidents, including accidents.
25. The radiation safety officer must work in close cooperation with qualified experts, if appointed, to ensure that all necessary duties and tasks are performed.

Qualified expert

26. The qualified expert, if appointed, must work in close cooperation with the radiation safety officer to ensure that all necessary duties and tasks are performed.

Manufacturer/supplier

27. The manufacturer/supplier of radiography equipment must:
- a) supply well-designed, well-manufactured and well-constructed radiography equipment that:
 - i) provides for protection and safety in line with the requirements of this code
 - ii) meets engineering, performance and functional specifications
 - iii) meets quality standards appropriate to the significance of systems and components, including software, for protection and safety
 - iv) provides clear displays, gauges and instructions on operating consoles
 - b) test radiography equipment to demonstrate compliance with relevant specifications
 - c) provide information on how to properly install and use radiography equipment and on associated radiation risks, including performance specifications, instructions for operating and maintenance, and instructions for protection and safety
 - d) optimise the protection provided by shielding and other protective devices
 - e) supply all radiography equipment with all appropriate radiation protection tools as a default, rather than as optional extras.
28. The manufacturer/supplier must:
- a) make suitable arrangements with managing entities to share information on use and operating experience that may be important for protection and safety
 - b) cooperate with the managing entity in accordance with clause 4(c).

Servicing engineer

29. The servicing engineer must:
- a) install and service radiography equipment competently, so that it complies with the requirements in clause 4
 - b) cooperate with the managing entity to ensure that radiography equipment cannot be used while it is being installed or serviced
 - c) after installing or servicing the equipment:
 - i) collaborate with the managing entity to ensure necessary quality control tests are completed successfully
 - ii) confirm that all radiation protection and safety features are in place and operating correctly before equipment is returned to use
 - iii) provide a written report to the managing entity describing the equipment fault (if any), the work done, parts replaced, adjustments made and any changes that may affect protection and safety.

Client

30. The client must:
- a) ensure that industrial radiography work is carried out only by managing entities that are appropriately licensed under the Radiation Safety Act 2016
 - b) give the managing entity sufficient lead time to plan the work and to carry it out safely
 - c) not impose contractual conditions or limitations that would hinder the managing entity from performing radiography work in a safe manner
 - d) ensure a safe working environment for radiographers, including:
 - i) the provision of scaffolding, adequate lighting and safe arrangements for working in vessels, confined spaces, trenches and other places where access might be necessary
 - ii) informing visiting radiographers about safety issues that are site specific and/or providing them with any necessary training thereon
 - e) ensure that radiography work is coordinated with other work on-site to minimise the risks to radiographers arising from site-specific hazards and to minimise radiation exposures to other workers
 - f) ensure the safe and secure storage of radiation sources whenever they are temporarily stored on the client's site.

Appendix 1: Cross-reference to Radiation Safety Act 2016

As required by section 87(1) of the Radiation Safety Act 2016, clauses in this code apply to the fundamental requirements in sections 9–12 of the Act as follows:

Section in Act	Clauses in this code
9(1)	1–8, 11–30
9(2)	1–30
9(3)	1–30
10	2, 4, 5, 17–23, 27–29
11	–
12	3, 5

Appendix 2:

Facility requirements

Exposure bay

The exposure bay must:

- be purpose designed for in-house radiography taking into account the outcomes of the safety assessment required in clause 2
- enable radiography equipment to be controlled from outside the exposure bay
- have access doors that are not exposed to the primary X-ray beam
- have a physical means such as a lockable door to prevent access to the exposure bay during radiography procedures
- have a mechanical or electrical interlock to ensure that:
 - X-ray equipment cannot be energised when the door is open
 - no one can access the exposure bay while an x-ray generator is generating X-rays
 - the generation of X-rays is terminated immediately if the door is opened
- have unambiguous and distinguishable visible or audible warning signals to display immediately before and during radiography procedures – these signals must operate automatically when an X-ray exposure is initiated
- have visible notices that clearly explain the significance of pre-warning and 'source exposed' signals posted at appropriate locations in and around the facility
- have means of rapid egress for persons in the exposure bay during radiography procedures
- have emergency stop buttons or pull-chords with manual resets installed to enable any person within the exposure bay to trigger an alarm immediately and to terminate or prevent radiation exposure, either automatically or by attracting the attention of the radiographer.

Storage room

The storage room must be:

- purpose designed for storage of radiography equipment
- fire resistant enough to minimise any loss of shielding and containment in the event of a fire in the vicinity
- remote from explosion and corrosion hazards.

Appendix 3:

Equipment requirements

Gamma sources

Radioactive source

Radioactive sources must:

- satisfy the requirements for special form radioactive material established in the International Atomic Energy Agency regulations for the safe transport of radioactive material (SSR-6)
- meet the requirements of ISO3999
- be leak tested in accordance with ISO3999.

Source assembly ('pigtail')

Source assemblies must:

- satisfy the requirements of ISO3999
- be compatible with the exposure device, ancillary equipment (such as guide tubes) and any source changer with which the assembly is used
- be marked with the radiation symbol (trefoil) and the legend 'RADIOACTIVE'
- be durably marked with the manufacturer's serial number.

Exposure device

Exposure devices must:

- satisfy the requirements of ISO3999
- be permanently and clearly labelled with:
 - the international ionising radiation symbol (trefoil)
 - the word 'RADIOACTIVE' in letters not less than 10 mm in height, together with a brief warning
 - the chemical symbol(s) and mass number of the radionuclide(s) for which the exposure device is suitable
 - the maximum source activity permitted in the exposure device, quoted for each radionuclide for which the exposure device is suitable

- the international standard to which the exposure device and its accessories conform
- the name of the manufacturer, the model number and the serial number of the exposure device
- if applicable, the mass of the depleted uranium shielding, or the indication 'contains depleted uranium'
- the managing entity's name, address and telephone number
- display information in a durable fireproof label or tag about the radioactive source currently in the exposure device, including:
 - the chemical symbol and mass number of the radionuclide
 - the activity on a stated date
 - the identification number of the sealed source
 - the identity of the source manufacturer.

X-ray equipment

X-ray equipment must:

- conform to national and international electrical safety standards
- have a cable length not less than 20 metres for site radiography
- be fitted with collimators for directional radiography
- incorporate beam filters to enable filtration to be matched to the work to be undertaken
- have a control panel that includes:
 - a label incorporating the radiation symbol, a legend indicating that X-rays are emitted when the equipment is operating and a warning label prohibiting unauthorised use
 - a key switch to prevent unauthorised use, with the key only removable when the switch is in off or standby positions
 - a labelled warning light that indicates when the equipment is enabled
 - a separate labelled warning light that indicates when the equipment is actually emitting X-rays
 - a timer that controls the exposure duration or an 'on' switch that requires continuous pressure by the radiographer to maintain the generation of X-rays
 - indicators that show the kilovolts and the current in milliamperes when the X-ray beam is on
 - a clearly labelled means of immediately terminating the generation of radiation
- have a means to prevent inadvertent movement of the X-ray tube head.

Leakage radiation passing through the sides of the X-ray equipment must be lower than 100 μSv per hour at 1 metre from the target.

Ancillary equipment

- All ancillary equipment must:
 - satisfy the requirements of ISO3999
 - be compatible with the specific exposure device and source assembly with which it is used.
- The length of control cables and guide tubes must be within manufacturer's recommendations.
- Collimators must be compatible with the source assembly.
- Source changers must:
 - meet the applicable requirements of ISO3999 and/or ISO2919
 - incorporate a system to ensure that the source is not accidentally withdrawn from the source changer when the connecting or disconnecting
 - include a lock or an outer locked container designed to prevent unauthorised or accidental removal of the sealed source from its shielded position.
- Storage containers must:
 - allow for the safe storage of sealed sources when not in use
 - meet the applicable requirements of ISO3999.

Appendix 4:

Training requirements

	RDG	TA	RSO
Fundamental concepts and measurements			
Basic radiation concepts	h	l	h
Radiation quantities and units	h	l	h
Radiation detection instruments	h	l	h
Biological effects of radiation	m	l	m
Principles of radiation protection			
Justification, optimisation and limitation	h	l	h
Regulatory requirements	m	l	h
Designation of controlled areas and supervised areas	h	l	h
Dose limits and investigation levels	h	l	h
Practical radiation protection			
Source outputs	h	l	h
Effects of time, distance, shielding	h	m	h
Individual monitoring	h	l	h
Practices to limit doses and maintain them ALARA	h	m	h
Storage of radioactive sources	m	m	h
Correct operation and maintenance of radiography equipment	h	m	h
Radiation protection programme	m	m	h
Local rules	h	m	h
Emergency plans	h	m	h
Management of radiation protection	m	l	h
End-of-life considerations for radiation sources	m	x	h
Accidents and other incidents	h	m	h
Emergency preparedness and response	h	m	h

Abbreviations used in this appendix

ALARA = as low as reasonably achievable

Parties

RDG = radiographer

TA = technical assistant

RSO = radiation safety officer

Level of knowledge

x = no requirement

l = low level of knowledge (general awareness and understanding of principles)

m = medium level of knowledge (basic understanding of the topic sufficient to influence practices undertaken)

h = high level of knowledge (detailed knowledge and understanding sufficient to be able to educate others)